



# Regional Collaboration to Build Community Resilience in Northern Virginia

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## FY18 FINAL REPORT

Northern Virginia Regional Commission  
March 2020 FY18 Task 83 Final Report to VACZMP

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## **I. Introduction**

The Intergovernmental Panel on Climate Change projects that the southeast region of the US, which includes Northern Virginia, will experience an increase in extreme precipitation events, more frequent and longer heat waves, and increased flooding from sea level rise and storm surge. These stressors combined with continued population growth and conversion of land from open to urban throughout the region, pose a risk for vulnerable people, assets, economies and ecosystems. The economic consequences of extreme climate events make resiliency planning at the regional level imperative and urgent.

In response to these acute and chronic challenges raised above, NVRC formed the “Northern Virginia Climate Resiliency Team” (NVCRT) in November 2016 with funding from a FY16 grant from the Virginia Coastal Zone Management Program. The purpose of the grant and team was to develop “[\*Resilient Critical Infrastructure: A Roadmap for Northern Virginia\*](#)”. The “Roadmap” identified the primary climate-related stressors facing the region, a series of objectives aimed at building resilience for critical infrastructure and a set of corresponding strategies that could be implemented to achieve the objectives.

The work conducted under this FY18 grant allowed NVRC to continue this important work by sustaining the Northern Virginia Climate Resiliency Team for another year to develop an implementation plan, begin to understand the economic impacts from extreme weather, and revise the Roadmap.

## **II. Deliverables**

### **a. NOVA Climate Resiliency Team Meetings**

NVRC coordinated the existing multi-stakeholder “Northern Virginia Climate Resiliency Team” created under during the first year of this grant. The “Team” is interdisciplinary and includes planners, technical and policy experts, scientists, and staff from local, state, and federal agencies in the region. NVRC coordinated and facilitate five meetings of the “Team” during this grant period to create shared learning opportunities and coordinate regional partnerships.

November 2018 – discuss best practices for implementation

October 2018 – Tools and Data Available to Implement Regional Resiliency Efforts

December 17, 2018 – FEMA Resilience Initiatives Supporting Local/Regional Resiliency Efforts

September 26, 2019 – Resiliency Planning Update presented to the Northern Virginia Regional Commission

Oct. 29, 2019: Economic Challenges of Climate Change

### **b. The Cost of Extreme Weather in Northern Virginia**

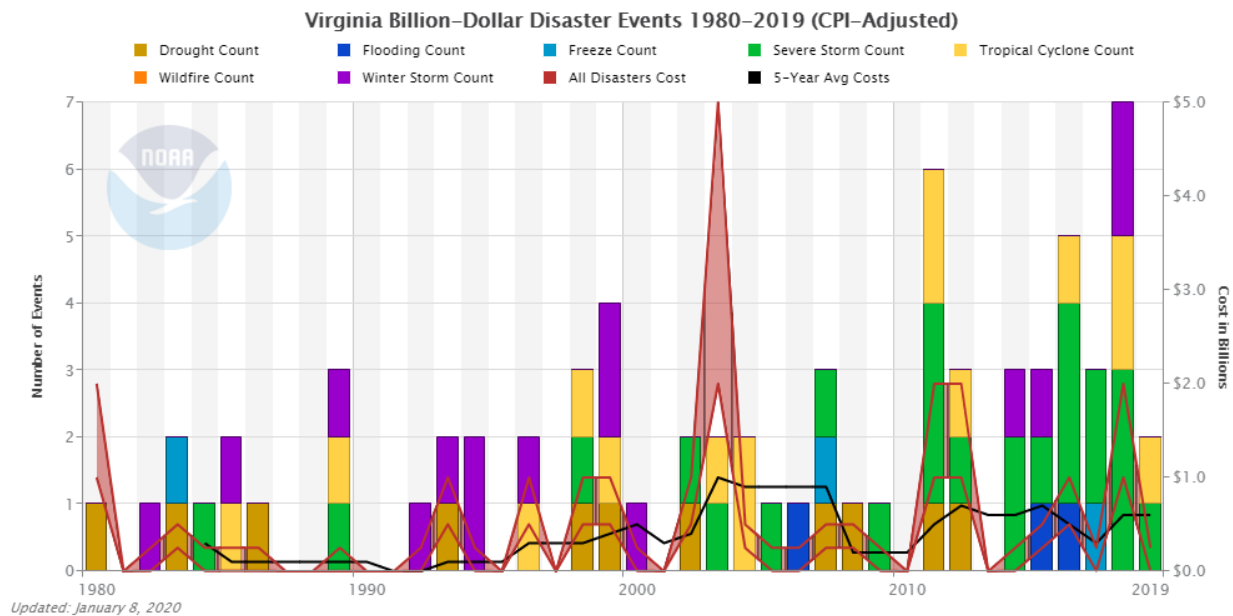
The U.S. has sustained 258 weather and climate disasters since 1980 where overall damages/costs reached or exceeded \$1 billion (including CPI adjustment to 2019). The total cost of these 258 events exceeds \$1.75 trillion (NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters

(2020). <https://www.ncdc.noaa.gov/billions/>).

Over the last several years costly disasters have been particularly destructive. The historic 2019 U.S. inland flooding across many Central states follows the historic 2018 and 2017 Atlantic hurricane and Western wildfire seasons, which set new damage cost records. These disasters have impacted dozens of states and territories (i.e., Puerto Rico and the U.S. Virgin Islands).

The number and cost of disasters are increasing over time due to a combination of increased exposure (i.e., values at risk of possible loss), vulnerability (i.e., how much damage does the intensity (wind speed, flood depth) at a location cause) and that climate change is increasing the frequency of some types of extremes that lead to billion-dollar disasters (NCA 2018, Chapter 2).

Virginia is no exception when it comes to costly extreme weather events. Between 1980 and 2019, 15 Tropical Cyclone, 24 Severe Storm, 15 Winter Storm, 3 Freeze, 3 Flooding, and 11 Drought billion-dollar disaster events affected Virginia (CPI-adjusted) (<https://www.ncdc.noaa.gov/billions/events/VA/1980-2019>).



Given the trend towards the increased frequency of billion-dollar weather events, a passive approach to protecting key infrastructure and assets from climate stressors may not be a cost-effective option.

Accurate accounting and recording of disaster losses is important for several reasons. Among the most important of these are federal government decisions about the provision of disaster relief assistance, e.g., how much, when, and in what form. For example, after an event, Preliminary Damage Assessments (PDA) are provided to FEMA. FEMA then uses those estimates to determine the type and amount of aid that is made available.

The PDA typically includes loss estimates to infrastructure, property, and crops. Indirect costs

such as business interruption, relief efforts, lost tourism revenue, relocation costs, disruption to transportation, electrical grid, and/or contamination of soil or water frequently aren't included in loss estimates. Unfortunately, the lack of standardized methods for direct and indirect loss and damage data collection, analysis, and reporting has posed challenges. Therefore, the data contained in this report only represents the direct losses as recorded by the National Climate Data Center (NCDC) database and is more than likely a massive underrepresentation of the true economic impact caused by extreme weather events.

Past flooding events in the region, have ranged widely in terms of location, magnitude, and impact. The most frequent flooding events are localized in nature, resulting from heavy rains in a short period of time over urbanized areas that are not able to appropriately handle storm water runoff. These events typically do not take lives or result in widespread property damage and do not trigger emergency or disaster declarations, thus historical data on economic impacts of these events is not available or difficult to find.

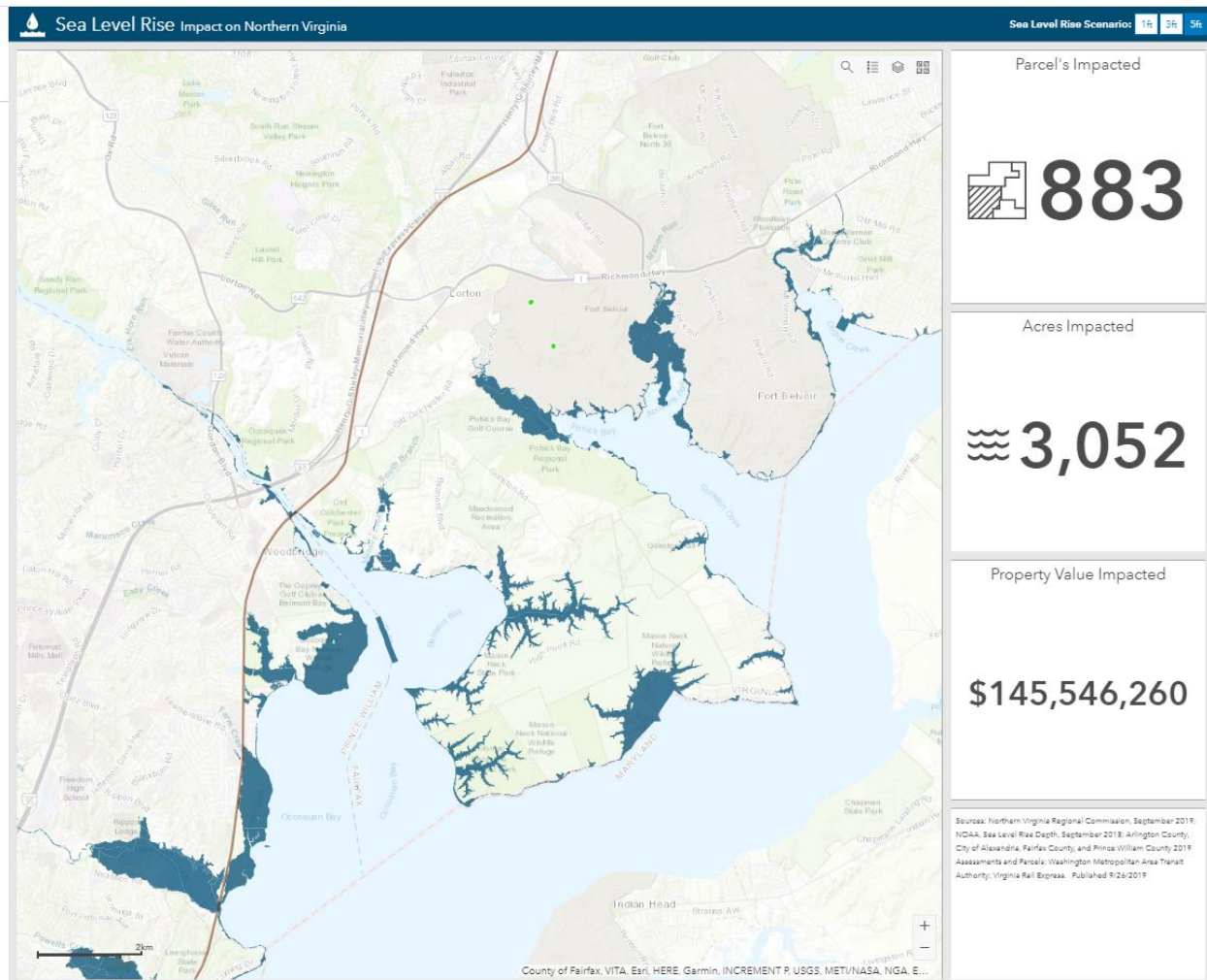
The Northern Virginia Hazard Mitigation Plan has summarized the number of flood events (by participating jurisdiction) since 1950 which have caused a notable impact on the Northern Virginia region as recorded by the NCDC. This includes 553 flood events that have caused approximately \$16.6 million in property and crop damages.

Table 1.

<b>Jurisdiction</b>	<b># of Flood Events</b>	<b>Property Damage</b>	<b>Crop Damage</b>	<b>Total</b>
Arlington County	45	\$4,123,000	\$0	\$4,123,000
Fairfax County	34	\$2,506,000	\$0	\$2,506,000
Loudoun County	130	\$2,138,000	\$180,000	\$2,318,000
Prince William County	84	\$775,000	\$50,000	\$825,000
City of Alexandria	33	\$718,000	\$0	\$718,000
City of Fairfax	34	\$2,506,000	\$0	\$2,506,000
City of Falls Church	36	\$620,000	\$0	\$620,000
City of Manassas	28	\$31,000	\$0	\$31,000
City of Manassas Park	18	\$11,000	\$0	\$11,000
Town of Dumfries	7	\$500,000	\$0	\$500,000
Town of Haymarket	9	\$173,000	\$50,000	\$223,000
Town of Herndon	9	\$0	\$0	\$0
Town of Leesburg	38	\$718,000	\$0	\$718,000
Town of Lovettsville	1	\$0	\$0	\$0
Town of Middleburg	13	\$500,000	\$0	\$500,000
Town of Occoquan	1	\$0	\$0	\$0
Town of Purcellville	16	\$500,000 \$0		\$500,000
Town of Quantico	6	\$507,000	\$0	\$507,000
Town of Vienna	7	\$0	\$0	\$0
<b>Total</b>	<b>553</b>	<b>\$16,326,000</b>	<b>\$280,000</b>	<b>\$16,606,000</b>

\* Damages are presented in year of occurrence values, as reported by the NCDC.

To understand the economic impact that projected sea level rise may have on property in the region, NVRC assessed sea level rise scenarios of 1 ft., 3 ft., and 5 ft. The assessment included the development of an [interactive story map](#) and dashboard that includes the number of parcels, acres, and assessed property value impacted in Northern Virginia by those scenarios. It does not represent a projection of potential direct or indirect damages to property or infrastructure.





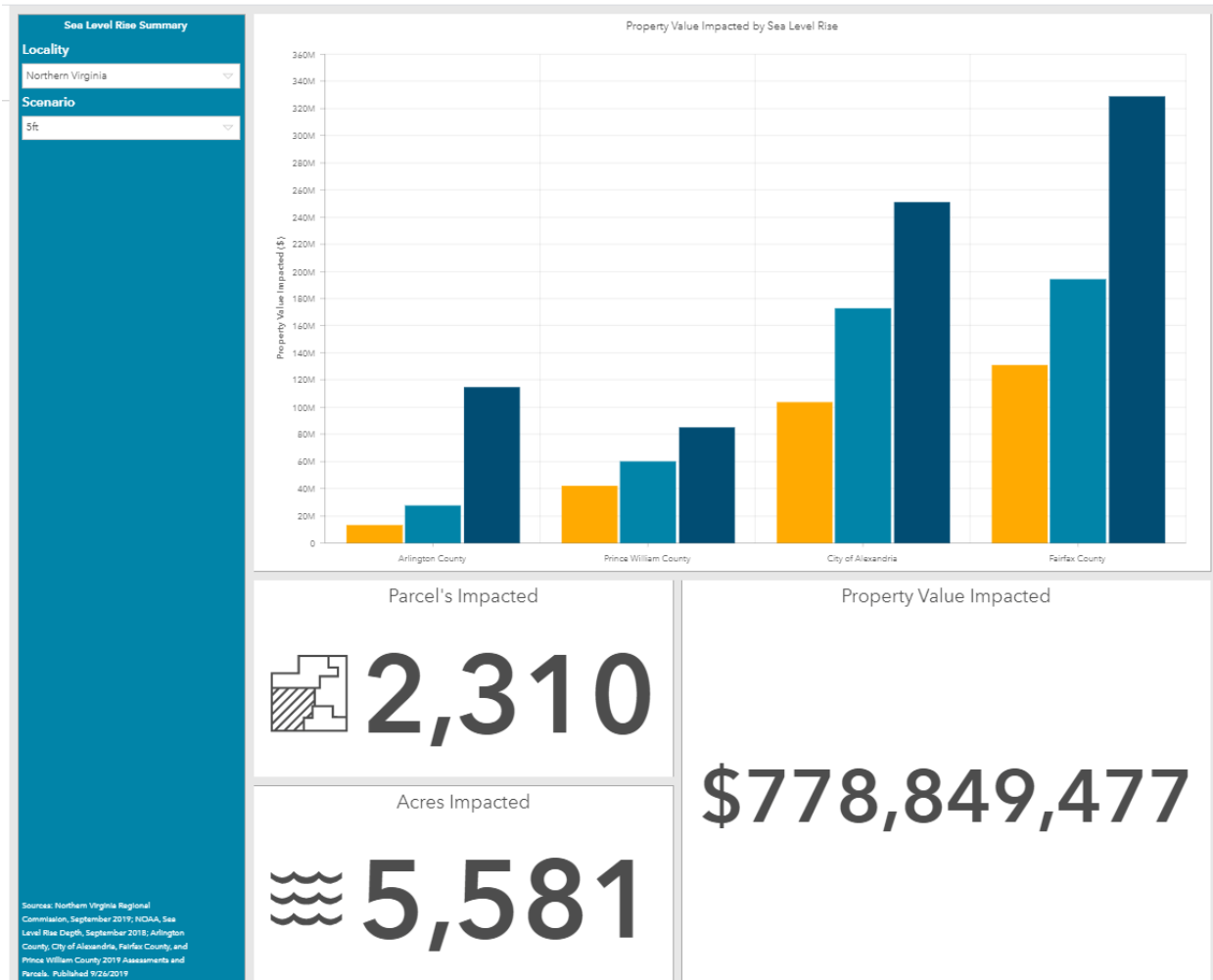


Table 2. Total Potential Impact of Sea Level Rise on Parcels, Acres, and Assessed Value

Sea Level Rise Scenario	Parcels Impacted	Acres of Impacted	Assessed Property Value Impacted
1 foot	1,159	3,610	\$288,101,510
3 foot	1,502	4,708	\$453,663,540
5 foot	2,310	5,581	\$778,849,477

This information can be used by local governments and infrastructure owners to begin to examine the potential benefits of investing in resilience to avoid or reduce direct and indirect losses.

### c. Roadmap Revision

The Roadmap was developed as a product of the first year of this three-year planning process. Best practices indicate that adaptive management yields the best results when developing plans

that involve elements of uncertainty. Adaptive management allows the lessons from current work to be applied to future projects.

Thus, it is important to periodically revisit the Roadmap and revise the objectives and strategies as more information becomes available. During this grant year, the Roadmap was revised to include two more objectives.

The first new objective is to **Maximize Green Infrastructure**.

When you think about infrastructure, transportation networks, water treatment plants, sewer systems, electrical grid, etc. is typically what comes to mind. The Department of Homeland Security identifies [16 critical infrastructure sectors](#)<sup>1</sup>. Natural landscapes and green infrastructure are not included in their list. However, as the climate changes, it has become more apparent that green infrastructure such as wetlands, forests, and streams are just as critical and provide many benefits to a city and its residents.

For example, urban parks can be designed to act like sponges during storm events and decrease flooding while filtering pollutants. A range of Low Impact Development (LID) practices such as rain gardens, bioretention areas, and permeable pavement can be installed in parks and public spaces. Cities all over the world are leveraging green infrastructure to complement the gray infrastructure such as large underground networks of pipes and tunnels.

In addition to reducing the risk from runoff, parks and open spaces can help to preserve the urban tree canopy and provide a place for native plant gardens. A healthy tree canopy in an urban area can improve air quality, reduce the heat-island effect and create close-to-home opportunities for outdoor recreation and experiences with nature.

Beyond the challenges emanating from a changing climate, many areas are also facing a national health crisis. Nearly half of all adults in the U.S. have chronic health conditions such as heart disease, diabetes and obesity, and 1 in 3 children is obese or overweight. Mental illness affects more than 46 million adults in the U.S., according to the National Institute of Mental Health<sup>2</sup>.

Physical activity can reduce or prevent serious health problems, and a nearby park equipped with the right facilities and programming can help get people outside and moving. Spending just 20 minutes outdoors, especially in green spaces, can improve overall health and happiness. It's been shown to lower stress, blood pressure and heart rate, while encouraging physical activity and buoying mood and mental health. Some research even suggests that green space is associated with a lower risk of developing psychiatric disorders.<sup>3</sup>

The second objective is to **ensure equitable access to resilient critical infrastructure**.

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<sup>1</sup> Department of Homeland Security, Critical Infrastructure Sectors <https://www.cisa.gov/critical-infrastructure-sectors>

<sup>2</sup> The National Institute of Mental Health (NIMH), Statistics on Mental Illness <https://www.nimh.nih.gov/health/statistics/mental-illness.shtml>

<sup>3</sup> Hon K. Yuen & Gavin R. Jenkins (2020) Factors associated with changes in subjective well-being immediately after urban park visit, International Journal of Environmental Health Research, 30:2, 134-145, DOI: 10.1080/09603123.2019.1577368

According to a recent analysis by the Pew Research Center<sup>4</sup>, the wealth gap between America's richest and poorest families more than doubled from 1989 to 2016 and the richest families are also the only ones whose wealth increased in the years after the start of the Great Recession (2007).

Shocks and stresses to infrastructure systems can have a disproportionate affect on low income families.

Public infrastructure investments can generate enormous community benefits—jobs, business opportunities, access to public transportation, and reliable services. But if investments are made without consideration to how it might affect the region's most vulnerable populations, these benefits may not be shared equitably. When investments in infrastructure are made, we must understand who benefits, who doesn't benefit, and how decisions were made.

Decisions regarding how to invest in resilience cannot be guided by economic considerations alone. A more comprehensive approach that includes an assessment of the socioeconomic impacts of infrastructure disruptions on vulnerable populations should be taken into account as well as the socioeconomic benefits of infrastructure investment.

These objectives were included in the revised [Resilient Critical Infrastructure Roadmap](#) which can be accessed from the NVRC website.

#### **d. Resilience Roadmap Implementation Plan**

Development of an implementation plan is a critical milestone in the community resiliency planning process. Implementation can take place at various levels, including regional and local, and through different means, including projects, policies or strategies. The following tables comprise the implementation plan for the objectives that were laid out in the Resilient Critical Infrastructure Roadmap for Northern Virginia.

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<sup>4</sup> The Pew Research Center. 6 facts about economic inequality in the U.S. <https://www.pewresearch.org/fact-tank/2020/02/07/6-facts-about-economic-inequality-in-the-u-s/>

**OBJECTIVE #1:****Understand Predicted Climate Scenarios including Conditions and Timelines**

Predicting future climate conditions is a complex undertaking based on a number of interacting models and assumptions. Because the way humans behave now will influence the rate of climate change in coming decades, there is no single set of climate predictions. Instead the Intergovernmental Panel on Climate Change (IPCC), publishes a series of projections for changes in temperature or precipitation based on the “Relative Concentration Pathways,” or the level of emissions that may be introduced into the atmosphere over time.

For example, if people do not adopt policy changes to reduce emissions, continue to have a high population growth, and continue to rely heavily on fossil fuels, this would lead to a “High Emissions” scenario or RCP 8.5. If people instead meet ambitious targets to lower fossil fuel consumption, increase renewable energy use, and maintain a lower population worldwide, lower (RCP 2.6). The climate projections referred to in this report are generally based on the GHG emissions scenarios outlined by the IPCC.

**IMPLEMENTATION PLAN**

Activity	Target Date	Resources Required	Lead Organization	Anticipated Product or Result	Progress	Notes
Track local and regional climate change indicators and document trends.	Fall 2020	A dashboard of regional climate change indicators based on local, state, and federally produced data.	NVRC/MARISA	Interactive graphs or spatial data layers posted on NVRC on-line dashboard site	Dashboard concept plan in place. Need to connect it to existing data sources	
Develop regional climate change scenarios depicting a scale of stressors and time frames.	On-going	Downscaled data on projections first; then can develop scenarios based on emissions levels	NVRC/GMU /AGU	Scenarios will be a part of the NVRC on-line dashboard based on emissions levels.	<a href="#">Sea level rise storymap</a> done; downscaled precip and temp. projections in progress.	NVRC working with GMU through TEX project on the downscaling of precip. Data
Identify threats to infrastructure from extreme weather events.	Initial Risk Assessment Screening Done		NVRC/Booz Allen Hamilton			Collaborated with Booz Allen Hamilton

**OBJECTIVE #2:****Assess Vulnerability Of Critical Built Infrastructure**

The key to increasing the resiliency infrastructure is to provide quantitative information about vulnerability and risks in formats that are useful to decision makers and the public. When the probability of natural disaster increases or the severity increases, the vulnerability of infrastructure increases in ways that are difficult to predict using historical events—the typical method used to assess risk. The uncertainty of future risk is problematic for policy makers and infrastructure planners who must make decisions about public investment that will take place over a long-time horizon. It is not possible to eliminate risk entirely. This objective aims to identify those risks that can be significantly reduced and identify those that need to be managed.

**IMPLEMENTATION PLAN**

<b>Activity</b>	<b>Target Date</b>	<b>Resources Required</b>	<b>Lead Organization</b>	<b>Anticipated Product or Result</b>	<b>Progress</b>	<b>Notes</b>
Identify the critical built-infrastructure in the region drawing from existing sources.	Spring 2019	GIS layers of infrastructure	NVRC	Interactive GIS webmap containing layers of infrastructure sectors	Done	NVRC worked with Booz Allen Hamilton to complete this activity
Screen the infrastructure using a Risk Characterization Matrix for different scenarios and timeframes.	Spring 2019	Matrix, coordination with local infrastructure operators	NVRC	Results are summarized in this document	Done	NVRC worked with Booz Allen Hamilton to complete this activity

**OBJECTIVE #3****Create Infrastructure Resilience Goals and Metrics to Measure Progress**

Developing goals and metrics for infrastructure resilience should be based on near-term community goals such as minimizing disruptions to daily life and speedy recovery from extreme events as well as longer-term community goals such as attracting new businesses and ensure a safe, reliable water supply exists for the area. The age and condition of existing systems, anticipated plans for improvements, vulnerability to projected conditions, and resources available should be considered. Achieving the long-term resilience goals of the community is made possible by developing metrics and performance goals and strategies for achieving those goals.

Additionally, the infrastructure that Northern Virginia relies upon for energy, transportation, water, and communications reach across multiple local, jurisdictions. Not only have individual infrastructure systems become more expansive, they have become increasingly interconnected and interdependent. Understanding the extent to which these systems are interconnected is critical to reduce dependencies

<https://globalresilience.northeastern.edu/app/uploads/2018/05/Resilience-Governance-for-Infrastructure-Dependencies-and-Interdependencies.pdf>

**IMPLEMENTATION PLAN**

Activity	Target Date	Resources Required	Lead Organization	Anticipated Product or Result	Progress	Notes
Use the <a href="#">NIST Community Resilience Guide</a> to work with communities to define goals.	TBD	Facility plans, Comprehensive Plans, detailed risk assessments and projected availability of resources	Individual communities in partnership with infrastructure operators and community stakeholders	Community driven resilience goals	TBD	
Identify measures to reduce infrastructure dependency and optimize resilience	On-going	Critical Infrastructure Dependency Analysis	TBD	Expansion of renewable energy purchasing options by investing in community solar and promotion of rooftop solar. NVRC created <a href="#">regional solar map</a> Cooperative negotiation with utilities for renewables or efficiency	NVRC helped negotiate an agreement with Dominion to transition existing HID streetlights in the region LED technology. NVRC also developed Solarize campaigns in participating jurisdictions.	

**OBJECTIVE #4**

Strengthen Regional Resilience Through Innovative Partnerships, Programs, And Pilots

Local governments that work collaboratively have more power to advocate for policy options to build resilience. Leveraging resources through shared learning, staff empowerment, and increased communication reduces duplicative efforts and results in cost-savings. Additionally, elected officials from local governments can collectively try to influence decisions at the state and federal levels in a bipartisan way to advance the region's positions on key legislative issues, budget priorities, and regulatory matters of importance to Northern Virginia.

**IMPLEMENTATION PLAN**

Activity	Target Date	Resources Required	Lead Organization	Anticipated Product or Result	Progress	Notes
Build on existing partnerships to increase capacity of the region.	On-going	Willingness and authority of agencies to collaborate	NVRC with MWCOG	NVRC will continue to provide support and technical assistance for jurisdictions seeking to collaborate recommendations and other sustainability and resilience measures.	On-going collaboration is necessary to increase capacity	NVRC working with GMU and AGU through TEX project on the downscaling of precipitation data
Consider developing new collaborative frameworks. Existing models include the Southeast Florida Compact, the Los Angeles Regional Collaborative for Climate Action and Sustainability, and others detailed in the Institute for Sustainable Communities' Regional Governance for Climate Action handbook.	Initiate contact with EPA in Spring 2020	Contact EPA about the regional resilience framework <a href="#">EPA about the regional resilience framework</a>	NVRC with EPA, COG, and individual jurisdictions	Feasibility of developing a similar model in NOVA by leveraging existing regional cooperation governing frameworks	NVRC contacted EPA to ask for technical assistance about the framework	
Identify current relevant	On-going	Inventory of existing	NVRC,	Recommendations of how to	MWCOG doing	

<b>OBJECTIVE #4</b> Strengthen Regional Resilience Through Innovative Partnerships, Programs, And Pilots						
partnerships and their roles.		committees, groups of stakeholders and roles	MWCOG	coordinate with other stakeholder groups in the region	gap analysis	
Identify and leverage existing resources and expertise in the DMV region including local college and university programs.	On-going	Inventory of firms or colleges/universities who may be willing to share research and outcomes with local govt.	NVRC with local universities such as GMU	Recommendations of how local govts. Can collaborate with scientists and experts from the region	NVRC already has a working relationship with GMU	The AGU/TEX program is a potential way
Coordinate climate, energy, and resilience policies among counties, municipalities, school districts, and other units of government in the region.	On-going	Participate in multidisciplinary coalitions of public, private, nonprofit, and/or academic stakeholders dedicated to climate, energy, and resilience issues.	NVRC in partnership with COG and other willing partners	Formation of collaborative coalitions to address regional challenges that cross sectors and jurisdictions. Adoption of regional tools and policy commitments by agencies.	NOVA Climate Resiliency Team is in existence to share information, tools.	
Share information about effective climate policies and implementation successes among jurisdictions, school districts, and other units of government through platforms like the Northern VA Regional Commission	On-going	Update resources regularly to capture new innovations and lessons learned from local implementation.	NVRC	NVRC will continue to bring together experts and local leaders to identify successful and innovative resilience practices through convening of NOVA Climate Resiliency Team, and MWCOG related committees	In-progress	
Work with partnerships that support the transfer and application of global best practices technical and policy	On-Going	Fall 2020-Winter 2021	NVRC	Peer-to-Peer technical exchange between GMU and the University of Stuttgart about the creation of a	In-progress	



<b>OBJECTIVE #4</b> Strengthen Regional Resilience Through Innovative Partnerships, Programs, And Pilots						
innovations from pioneering countries such as Germany.				NOVA “Climate Atlas”. Conducting technical/policy exchange to study best practices resiliency efforts in Hamburg, Germany. Support for peer-to-peer technical exchange by aquatic biologist from TU Munich to Chesapeake Bay region to study watershed restoration best practices.		
Collaborate to pursue external funding and technical assistance for projects that improve resilience in the region.	On-going	Identify sources for grants or cost share	Agencies from the region	MWCOG brought stakeholders together to cost-share in a USACE Coastal Storm Risk Study	In-progress. Has a 3-year timeframe	When complete, the study will have USACE recommended projects that qualify for federal funding.

**OBJECTIVE #5**

Optimize Existing Policies to Incorporate Resilience

**BACKGROUND**

Local governments and other agencies can integrate consistent resilience goals into their comprehensive, economic development, zoning, mitigation, and other local planning activities that impact buildings, public utilities, and other infrastructure systems. Many tools have been developed to help planners understand successful best practices.

**IMPLEMENTATION PLAN**

Activity	Target Date	Resources Required	Lead Organization	Anticipated Product or Result	Progress/Outcome	Notes
Determine the appropriate suite of policy or planning tools that may be best suited to address future recommendations for implementation of resilience actions.	On-going	Virginia Coastal Resilience Master Plan; Sea Level Rise Projection Guidance for Local Governments; Freeboard Guidance for Local Governments	Chief Resilience Officer/Secretary of Natural Resources; Special Assistant to the Governor for Coastal Resilience; NVRC; local jurisdictions	Guidance and/or authority from the state for sea level rise and flooding resilience	NVRC is actively coordinating Special Assistant to the Governor for Coastal Adaptation and Protection	NVRC is also working collaboratively with the other 7 coastal PDC's to exchange ideas and best practices
Use the EPA Flood Resilience Checklist or similar to determine how well the jurisdictions in the region are positioned to avoid and/or reduce flood damage and to recover from floods and understand where gaps in policy are.	On-going	<a href="https://www.epa.gov/smartgrowth/flood-resilience-checklist">https://www.epa.gov/smartgrowth/flood-resilience-checklist</a>	Individual jurisdictions	Resilient Flood Strategy for local jurisdictions	NVRC is planning a flood strategy workshop show and tell to share ideas	

Participate in FEMA's Community Rating System.	On-going	Nearly all NOVA jurisdictions participate.	Individual jurisdictions	Reduction in flood insurance plus other co-benefits	Most localities already participate however there is always room to improve scores to.	Wetlands Watch offers CRS trainings
Use tools such as Georgetown Climate Center's " <i>Adapting to Urban Heat: A Tool Kit for Local Governments</i> " or the American Council for an Energy-Efficient Economy " <i>Cool Policies for Cool Cities: Best Practices for Mitigating Urban Heat Islands in North American Cities</i> " to determine how urban heat island mitigation measures can be built into existing planning and policy frameworks.	TBD	NVRC can help to identify other places that have used these tools to determine effectiveness.	Individual jurisdictions	Reduction in urban heat island effect	NVRC plans to create an urban heat island map for the region to help identify and prioritize areas.	
Use tools such as Georgetown Climate Center's " <i>Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use</i> " to determine how resilience from sea level rise and coastal storm surge can be integrated into Comprehensive Plans, Hazard Mitigation Plans and other planning frameworks.	TBD	NVRC can help to identify other places that have used these tools to determine effectiveness.	Individual jurisdictions	Identification of actions that reduce the vulnerability to and consequences of sea-level rise	The Virginia Coastal Master Plan will have recommendations	<a href="https://fas.org/sgp/crs/misc/R44632.pdf">https://fas.org/sgp/crs/misc/R44632.pdf</a>

**OBJECTIVE #6**

Develop A Database of Potential Projects That Enhance Resilience

**BACKGROUND**

It is critical to promote the development of “shovel ready” projects at the local level not only for new funding opportunities, but to prepare communities in advance of a natural disaster. If we aren’t planning and prepared before a disaster, recovery funding will be directed to states who have a plan in place.

Virginia’s Coastal Resilience Master Plan has the potential to act as a catalyst for this work. With the prospect of new state funding on the table, localities can be incentivized to develop more detailed resilience-building proposals in innovative new ways.

**IMPLEMENTATION PLAN**

Activity	Target Date	Resources Required	Lead Organization	Anticipated Product or Result	Progress	Notes
Incorporate resiliency measures into capital improvement projects that are already planned.	On-going	Evaluation of CIP projects with a resilience lens	Individual jurisdictions	CIP projects that are more resilient	In-progress	NVRC working with GMU through TEX project on the downscaling of precip. Data
Prioritize infrastructure projects that are already planned will have the most impact on resilience.	On-going	can develop scenarios based on emissions levels	NVRC	Prioritization of projects that incorporate resilience	In-progress	
Develop a database of projects that can increase resilience so that when grant funding becomes available, a suite of projects have already been identified.	On-going	A database that is populated, updated and managed.	Wetlands Watch/DEQ	<a href="https://static1.squarespace.com/static/56af7134be7b96f50a2c83e4/t/5d715eba77a52f0001781832/1567710915543/Final_CZM_Database_Report_webupload.pdf">https://static1.squarespace.com/static/56af7134be7b96f50a2c83e4/t/5d715eba77a52f0001781832/1567710915543/Final_CZM_Database_Report_webupload.pdf</a>	The database and report have been created and NVRC will help to populate it over the next three years	Wetlands Watch currently controls the database

<b>OBJECTIVE #7</b>						
<b>Communicate With Stakeholders</b>						
<b>BACKGROUND</b> <p>Climate change is already affecting Northern Virginia communities, and the best available science indicates these impacts will continue to get occur and may get worse. In order to protect property, health, and the regional economy, local governments across the region need to communicate with one another as well as with the public. There is a need to engage residents in ongoing conversations about what is at risk and actions to take to become more resilient.</p>						
<b>IMPLEMENTATION PLAN</b>						
<b>Activity</b>	<b>Target Date</b>	<b>Resources Required</b>	<b>Lead Organization</b>	<b>Anticipated Product or Result</b>	<b>Progress</b>	<b>Notes</b>
Develop a multi-media stakeholder engagement plan.	TBD	ID target audiences and messages	TBD; however individual jurisdictions are most familiar with their own community stakeholders.	Build public awareness of the climate-related risks facing Northern Virginia. Interactive graphs or spatial data layers posted on NVRC on-line dashboard site can be used	Sea level rise storymap done; downscaled precip and temp. projections in progress. Dashboard plan in place	Dashboard will be done by end of 2020. NVRC to develop one-page fact sheets and/or infographics
Continue to convene the Northern Virginia Climate Resiliency Team.	On-going	Continued participation from jurisdictions and other agencies	NVRC	At least four meetings per year to continue to bring together experts and local leaders to identify successful and innovative resilience practices.	Meetings will continue to be scheduled at least quarterly through 2022	
Partner with schools and universities to engage students.	TBD	Communication with schools and students.	Local school systems	Communication with school systems.	TBD	
Make information accessible to all through public exhibits and displays.	TBD	Identification of how public spaces could be utilized for exhibits or displays.	Individual jurisdictions	Signage, exhibits, or displays that serve as an education and outreach tool.	TBD	Regional museums may be good partners

<b>OBJECTIVE #7</b>						
<b>Communicate With Stakeholders</b>						
Crowd-source ideas.	TBD	A way to solicit public engagement to generate innovative ideas	TBD	Innovative ideas generated by individuals from the public	TBD	A concept that has worked in other places. Could be explored for application here.
Keep elected officials informed.	On-going	Progress reports and briefings for elected officials	NVRC/local staff	NVRC staff briefed Commissioners in Oct. 2019 and updates are provided through monthly Exec. Director Report to commissioners	On-going	

## **Appendix A**

### **Northern Virginia Climate Resiliency Team Meeting Summaries**

## Report from the October 29, Northern Virginia Climate Resiliency Team Webinar

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### AGENDA

28 Participants

**12:00** Introductions and Roll-Call

**12:10 Economic Challenges of Climate Change**

**Bilal M. Ayyub, PhD.**

Director, Center for Technology and Systems Management

Professor, Department of Civil and Environmental Engineering

University of Maryland, College Park

**1:00 What Happened on July 8<sup>th</sup> in Arlington?**

**Aaron Miller**

Director of Public Safety Communications and Emergency Management

Arlington County

**1:45 Outcomes of Risk Assessment Workshop**

**Corey Miles**

Senior Environmental Planner

NVRC

**1:55 Game Plan for 2020 and future topics**

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**Dr. Bilal M. Ayyub, PhD.**

**University of Maryland**

**“Climate Resilient Infrastructure”**

Resilience Quantification



- Natural disasters, including climate change, are occurring with greater regularity and with greater quantifiable costs to infrastructure. Between 2005 and 2014, natural disasters worldwide caused over \$1.4 trillion in damage, affected 1.7 billion people and killed 700,000;
- US coastal regions, such as the Washington DC region, are increasingly vulnerable to multiple climate stressors/disturbances, such as sea-level rise, storm surges or heat;
- “Persistence of functions and performances under uncertainty in the face of disturbances” is a means of framing “resiliency” of infrastructure;
- A key quantitative attribute of resiliency to assess critical infrastructure is economic development. But this alone is insufficient given the relatively long-term time period and extreme complexity of recovery processes (such as those affecting New Orleans in the aftermath of Hurricane Katrina, in which 1,833 people perished and caused \$108 billion in damage);
- Others include performance measures for infrastructure might include “through-traffic” (transportation); “water production capacity” (water treatment plants); or “protection provided” (coastal zone management).

#### Extreme Hazard Projections & Climate

- Significant challenges prevail with downscaling climate models and framing prognosis from global scale down to the regional in order to assess infrastructure threats. Assessing these threats, too, is affected by the complexities of global climate phenomena such as precipitation, greenhouse gas emissions trends/modeling, temperature, geology, poor quality of existing infrastructure, winds, time/duration etc.

#### Resilience of Networks – Case Study of Washington DC Metrorail

- Washington DC metros have relatively high resiliency/protection from flooding via sea-level rise or hurricane-induced storm surge. But several stations in Northern Virginia (such as Pentagon or Court House) are at a moderate risk.

#### Designing and Planning Climate Resilient Infrastructure

- American Society of Civil Engineers is developing design standards for new and existing infrastructure in the U.S. (\$1.3 trillion in construction each year in the United States alone);
- Design dilemmas for engineers in this context are the needs to balance longevity of infrastructure, cost and uncertain climate conditions;
- Designs and analytic methods by ASCE (see ASCE Manual of Practice #140) include “hard” design alternatives (see case study for LOSSAN Rail Corridor) as well as “nature-based” solutions (e.g. beaches and dunes) and hybrids between the two;

#### Socio-Economics of Resilient Infrastructure

- Socio economic resilience is a measurement of an economy and society's ability to minimize the impact of asset losses on well-being (measured by welfare loss) from phenomena such as climate change;
- Socio-economic attributes are vital for a systemic, iterative and multi-hazard approach to resilient infrastructure planning.

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### **Aaron Miller, Arlington County**

#### **"What Happened on July 8<sup>th</sup> in Arlington?"**

- A once-in-a-century storm occurred and dropped over 10 cm of rain between 9:00am and 10:00am, July 8, 2019, forcing a flashflood emergency for the County;
- Six pedestrian bridges along Four Mile Run were destroyed, 38 emergency water rescues and over \$10 million in damages to businesses and homes;
- Stormwater infrastructure in parts of Arlington County were not equipped to handle the intensity of the rainfall;
- Flood resilient Arlington County is link to Arlington was mostly farmland;
- The County made available \$200,000 loans to individuals and \$2,000,000 to small businesses affected by the storm for recovery and redevelopment;
- Post disaster planning efforts by Arlington County have focused on daylighting and water retention within watersheds and flood liability education efforts to property owners.

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### **Corey Miles, NVRC**

#### **Outcomes of March 2019 Risk Assessment Workshop**

- The workshop evaluated critical infrastructure and effects by climate stressors through the lenses of a system rather than a single asset;
- Sea level rise stressor was revealed to cause approximately \$3.0 million in damage to critical infrastructure such as transportation systems (e.g. roads);
- Severe storm events and flooding is a second critical stressor to infrastructure. The assessment process identified the costs related to flooding from 500-year and 100-year floods
- The workshop assessed that severe heat affected energy distribution stressors
  - Energy transportation was most affected,
- NVRC work complements US Army Corps of Engineers work to assess flood risks in Northern Virginia
- NVRC and MWCOG are working together to assess benefits to protecting critical infrastructure of fused hard and soft engineering;
- Virginia Executive "Order 24" will enhance and complement both NVRC and MWCOG/USACE resiliency efforts with the possible elevation of state involvement and support. Admiral Ann Richards' creation of a data base populated with potential projects and participants from around the Commonwealth;

## Notes from the NOVA Climate Resiliency Team Webinar – December 17, 2018

12:00pm to 2:00pm

(27 Participants)

### Agenda

12:00 Introductions

12:10 FEMA Resilience Initiatives

*Mari Radford (Community Planning Lead, Risk Analysis Branch, FEMA Region 3)*

1:00 Community Rating System Assistance and Resilient Projects Database

*Mary-Carson Stiff (Policy Director, Wetlands Watch)*

1:15 Updates

*Corey Miles (NVRC) and Amanda Campbell (MWCOC)*

### **FEMA Resilience Initiatives Supporting Local/Regional Resiliency Efforts**

- FEMA studies have calculated that natural hazard mitigation planning provides \$6.00 of economic benefits for every \$1.00 invested;
- FEMA financial and grant that support regional and local planning efforts (including flood and drought mitigation) include:
  - o Hazard Mitigation Grant Program (HMGP)
    - <https://www.fema.gov/hazard-mitigation-grant-program>;
  - o Pre-Mitigation Disaster Mitigation (PDM)
    - <https://www.fema.gov/pre-disaster-mitigation-grant-program>;
  - o Flood Mitigation Assistance (FMA)
    - <https://www.fema.gov/flood-mitigation-assistance-grant-program>
- FEMA grants and funding cover “all hazards” and provide a 25% non-federal cost share match;
- Other FEMA programs that support potential mitigation planning in Northern Virginia include:
  - o Public Assistance Section 406 Mitigation;
    - <https://www.fema.gov/news-release/2017/05/03/4309/fema-hazard-mitigation-grants-404-and-406>
  - o Emergency Management Performance Grant (EMPG) – Given to Commonwealth of Virginia;
    - <https://www.fema.gov/emergency-management-performance-grant-program>

- National Disaster Recovery Framework (Grants up to \$30,000 to bring structures into compliance;
    - <https://www.fema.gov/national-disaster-recovery-framework>
- Virginia-specific programs with FEMA support that have contributed to mitigation planning include:
- Commonwealth of Virginia’s Hazard Mitigation Plan (approved for the period 2018 – 2023);
  - State’s priorities within plan include:
    - Community impacts;
    - Reduce risks of high hazards;
    - Secure return on investment;
    - Identify mitigation alternatives and project development processes;
    - Holistic approaches;
- The plan has guided recovery efforts in Virginia following Hurricane Matthew;
- Strengthening funding of future local mitigation planning efforts starts with a “Patchwork Quilt” of prospective funds;
- Prospective plans need to promote outreach and inclusion;
- Successful plans will integrate other relevant local/regional plans and planning processes;
- Prospective mitigation plans should consider the effects of reviews of bond rating agencies (e.g. Moodys and Standard and Poors) who seriously consider/evaluate local hazard mitigation plans and climate change;
- Plans should draw from and consider EMAP accreditation;
- Prospective plans should consider inclusion of CRS flood insurance discounts as well as reviews of resiliency/mitigation plans.

### **Community Rating System Assistance and Resilient Projects Database**

Mary Carson-Stiff & Ross Weaver (Wetlands Watch)

#### Coastal Virginia Resilience – Community Rating System (CRS) Research

- Resiliency planning relies on data-driven assessments (for example soil, structural integrity, social vulnerability, groundwater, stormwater management, etc.);
- Communities in Virginia have tended to overlook funding and grant resources (such as the *Clean Water Revolving Loan Fund* or the *Stormwater Local Assistance Fund*);
- CRS recommendations for enhancing resiliency planning in Northern Virginia;
  - Assess potential credits for improved stormwater management (e.g. inspections of drainage systems before storms);
- CRS recommendations for regional coordination in Northern Virginia

- Outline feedback received by Wetlands Watch on how cost-share position providing CRS support across multiple jurisdictions might work in Virginia;
- Utilize Wetlands Watch's local government training opportunities available through VA Coastal zone regional planning (eligible communities of this region include Loudoun County, City of Fairfax, City of Manassas, City of Manassas Park, Town of Dumfries, Town of Herndon, Town of Leesburg);
- Wetlands Watch might also assist in the development of a "natural resilience database" to aid communities of Northern Virginia better position localities to access grants from various sources in the development of resiliency plans – plans for utilization/inclusion include;
  - CZM policy team meeting in Richmond, Virginia, January 30, 2019;
  - Marsh resilience summit meeting in Williamsburg, Virginia, February 5-6, 2019;
  - Database workshop to be held in Virginia in February, 2019

## Updates

- American Geophysical Union/George Mason University/Northern Virginia Regional Commission "Thriving Earth Exchange" Project
  - This team is working to integrate future climate-effected precipitation trends at regional level with stormwater models for 3 watersheds in Northern Virginia (Four Mile Run, Occoquan and Cameron Run) is still in data-gathering mode. Potential for partnership with University of Stuttgart.
- MWCOG/Army Corps of Engineers Risk Assessment Study
  - The proposed 3-year study will assess potential flood scenarios for capital construction projects along coastal shorelines of the Potomac River of the DC region. MWCOG signed agreement with the USACE in July 2017, with a geographic focus on DC, Maryland and Virginia, but now focused only on Virginia. The resulting loss of funding has forced a search for cost-sharing among Virginia jurisdictions. Cost of study is \$3.5 is entire cost of project, and is dependent on a ½ cost-share that is locally sourced.
- Virginia EO Announcement || NVRC Base-Community Partnerships
  - NVRC working with region's military bases to promote resiliency efforts. Base commanders see climate change as a "force multiplier." Governor Northam has identified a special assistant for climate resiliency to advise him and selected Admiral Ann Philips. MWCOG and NVRC will invite Admiral Philips to a future meeting of Resiliency team.

## FOLLOW-UP

- Circulate to Team a Copy of Commonwealth of Virginia's Hazard Mitigation Plan

## **Meeting Summary: October NOVA Climate Resiliency Team Virtual Meeting**

### **20 Participants**

**Summary:** The Northern Virginia Climate Resiliency Team convened a discussion of tools and data for potential use in the implementation of the Resiliency Roadmap. Two speakers helped facilitate the discussion.

- Dr. James Kinter, Director, George Mason University Center for Ocean-Land-Atmosphere Studies, shared science-based global, national and regional-level trends related to climate change and addressed trends relevant to Northern Virginia – Specifically, the American Geophysical Union/Northern Virginia Regional Commission/George Mason University “Thriving Earth Exchange” project (TEX). TEX endeavors to link the expertise of climate science community from AGU and GMU to assist with local/regional resiliency efforts in Northern Virginia. The science and technical staff at GMU are assisting the NOVA resiliency team to assess future precipitation patterns in the face of a changing climate and model the effects on stormwater runoff.
- Dr. Michelle Miro, an Associate Engineer at the RAND Corporation, spoke about the work of the Mid-Atlantic Regional Integrated Sciences and Assessments program (MARISA), a five-year National Oceanic and Atmospheric Administration-funded project to support integrated, flexible processes for building adaptive capacity to climate variability and change in diverse settings in the Chesapeake Bay Watershed. Ms. Miro demonstrated several features of the new Climate Data Portal which will be available later this fall.

### **Review of NOVA Resiliency Progress to Date:**

- Completion of the NOVA Resiliency Roadmap in the first half of 2018;
- Renewed Grant for 12 additional months (insert dates);
- Development of the AGU/NVRC/GMY Terrestrial Earth Exchange (TEX) Project;
- Sustained Work on Shoreline Monitoring of NOVA Coastal areas;
- Members of team took part in an environmental and social justice/resiliency planning workshop offered by the Institute for Sustainable Communities in Pittsburgh in April.

### **Science-Based Climate Related Challenges: Global, National and Regional – Dr. James Kinter:**

- Science suggests that today, the climate is changing and there is a high probability that human influence is contributing to that change;
- Climate science is in part the fusion of probability and statistics of weather

- Data assessed to date suggests that there has been a rise from 2 watts per square meter of the earth's surface that is projected to 8 watts by 2100 in the absence of relevant global climate governance structures to curb emissions;
- Anthropogenic CO2 emissions emanate from land uses that include deforestation, urbanization (especially emissions of fossil fuels);
- The science of climate must endeavor to assess the effects of "carbon sinks" such as oceans and atmospheric phenomena (such as volcanic eruptions);
- Last 100 years have witnessed a rise of 1 degree Celsius of the global average temperature (about 2F); The poles are warming about twice as fast as the equator
- Recent phenomena highlighting the rise of the global average temperature with seven times as many record highs as lows in the last few years (?); new measurements and observations of ice sheet melt and their contributions to sea level rise
- Climate trends that are forecast nationally include more intense and voluminous rainfall in the eastern US and prolonged drought in the western US;
- Studies of emissions trends models suggest emissions increases over next century, but vary depending upon the adequacy of global climate regimes and governance systems;
- Paul Hawken's Project Drawdown provides one example of a feasible, economical response to reign in climate change emissions and reduce long term problems

#### Chesapeake Bay Region-specific

- The Chesapeake Bay must cope with the phenomena of "glacial isostatic adjustment", or how the geology surrounding the Chesapeake Bay is no longer re-bounding from the compression of the ice age. This is likely to promote sinking in regions such as the tidewater;
- The melting of the ice sheets suggests higher levels of nuisance flooding;
- Cities of the Chesapeake will be forced to cope with new terminology and benchmarks concerning "nuisance flooding" and flood zone management to 2100 and beyond;
- The Chesapeake must also cope with new norms for flooding and extreme rain events; (ex. Ellicott City experienced two 1000-year floods in two years)
- Tropical cyclones are creeping northward, slowing down and taking unusual tracks (ex. Florence, Harvey). There is the threat of the possibility of additional storms with the force of "Superstorm Sandy";
- The acidification of oceanic waters will weaken and make more vulnerable shellfish populations;
- Importance of projects such as TEX to help local and regional efforts cope with anticipated changes of climate change, especially stormwater.

## **Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA)/Risk Characterization Matrix – Dr. Michelle Miro**

- Launched in September 2016, the Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA), is a five-year NOAA-funded program implemented by the RAND Corporation in partnership with Cornell, Penn State and Johns Hopkins Universities. MARISA is designed to support the integration of federal climate science efforts in the development of adaptive capacities by sub-national and other organizations that are working to respond to climate variability and change within the Chesapeake Bay watershed.
- MARISA's objectives include assessing climate risks, uncertainties, and vulnerabilities and assess adaptation planning efforts and decision-making.
- The MARISA Climate Data Portal was demonstrated. The Portal will include historic and downscaled projections of temperature and precipitation, generate climate-related variables and metrics and characterize key flooding risks for the region
- The first edition of the portal will be available in the coming weeks for input and review at <http://marisa.psu.edu/data>

**Next meeting:** December 4, 2018 to discuss application of qualitative and quantitative resiliency tools